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ABSTRACT

The purpose of this study was to determine if alternative modes of science methods instruction differentially affect pre-service elementary teachers: (1) beliefs about science teaching; (2) general attitudes toward teaching; and (3) beliefs about the relative importance of specific teacher behaviors. The subjects were 90 students enrolled in three alternative science methods courses. One course was taught in an open classroom mode where field experiences in selected team-taught open classrooms accounted for over half of the instructional time. One course was taught in a self-contained classroom mode. The third course was the traditional on-campus science methods course which used very few field experiences. The instruments used in the study were the PMT Questionnaire, a science-teaching affective attitude instrument, and a Science Behavior Classroom Q-sort. The first two instruments were given as pre- and post-tests, whereas the third was only a post-test. As a result, the students in the different courses did exhibit different attitudes and beliefs about science teaching. Students in the open classroom ranked items about student structure higher than did students in the other sections, and also had a preference for ESS materials. Guided discovery and rational enquiry models of instruction appeared to be the most useful for on-campus students. (Author/RE)

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AN INVESTIGATION OF THREE APPROACHES FOR SCIENCE METHODS INSTRUCTION OF PRE-SERVICE ELEMENTARY TEACHERS

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INTRODUCTION

The pre-service elementary teachers at The University of Arizona come from a variety of backgrounds and social environments. Many of them also plan to return to the same social mileau. Their prior experiences in schooling have shaped their present attitudes about teachers, teaching, and subject matter taught. These diverse attitudes and beliefs have been of importance in determining alternative science and science education courses at the university. Many changes have been introduced into the framework of the liberal arts science courses as well as the elementary science education courses. These courses, four in the science areas and one in science methods, have been developed around a framework of science attitudes, content, and process skills.

RATIONALE AND THEORETICAL BASIS

Attitudes and beliefs about education and teaching have been the topics of many research studies. They have previously been shown to affect teaching styles and teaching behaviors. An early study by Sprinthill, Whitley, and Moses (1966) found that cognitive flexibility, which is an attitude, and effective teaching, which is a behavior, were related. Additionally Gough, Durflinger, and Hill (1968) showed that under certain conditions attitude measures predict behavior fairly well. Yager (1966) also emphasized that a teacher's attitude has an effect on the degree of content achievement, growth of critical thinking skills, and students' attitude toward a given course in science. Thus attitudes, beliefs, and values determine characteristic ways an instructor teacher classes

and can have important consequences for students' learning, satisfaction, and development.

However although the relative role of the teacher and student and the purpose of teaching and learning are defined, each teacher fulfills this role in different manners. Research on teaching styles in science has failed to show one method of instruction superior to all other methods. Victor (1978) has stated that no single strategy can be used to teach all aspects of elementary science. The strategy or combination of strategies that lends itself best to the effective learning of a particular process skill, concept, or conceptual scheme is the "best". Bush (1954) similarly presented data to show that no teacher or method was effective with all pupils. Horak (1976) has presented evidence to show that there are different science teacher types and Cunningham (1975) has shown the existence of four teacher types which were shown to be not equally effective with all types of students.

Overall the preceding research generally has shown that attitudes, beliefs, and values can be grouped and analyzed, do determine characteristic ways an instructor teaches classes, and can have important consequences for student's learning, satisfaction, and development. But since attitudes and beliefs about teaching change slowly, it may be conjectured that pre-service teachers would be most interested and show most enthusiasm toward implementing science instructional programs that are most congruent with their beliefs. The purpose of this study was consequently to determine if alternative modes of science methods instruction differentially affect pre-service elementary teachers (1) beliefs about science teaching, (2) general attitudes toward teaching, and (3) beliefs about the relative importance of specific teacher behaviors.

METHOD

Design: A non-randomized control group pretest-posttest design was used in this study (Ary, Jacobs, and Razavieh, 1972, p. 254). Since randomization was not possible, a pretest of the PMT Questionnaire and the Science Attitude Scale were administered during the first class meetings. The pre-test score was utilized to show equivalence of the groups on the science attitude scale. They were used as a co-variate on the PMT Questionnaire posttest scores since analysis showed that the groups were not equivalent with respect to this criterion measure. Overall the study may possible be limited from the standpoint that specific selection differences may have resulted in an interaction effect between selection and certain other extraneous variables not assessed.

Sample: Subjects for this study were 75 college students enrolled in elementary science methods classes. The students were not randomly assigned to the specific sections in which they were enrolled. From the original sample complete data was collected from all 75 students on the Science Behavior Q-sort, from 73 of the students on the PMT questionnaire, and from 50 students on the science teaching attitude scale. The others either did not attend class during the administration of the criterion measures or did not complete the entire instruments.

Instruments: The criterion measures for the study were the PMT Questionnaire (Wiggins, 1973), a science teaching attitude instrument (Good, 1971) and a Science Behavior Classroom Q-sort (Horak, 1976).

The PMT Questionnaire has exhibited construct validity and split half reliability of 0.91 based upon large samples of in-service elementary teachers. The instrument is a 57 item Likert type response scale which contains 3 subscales that tap the domain of teacher's attitudes about classroom management and control,

use of punishment in the classroom, and trust of students.

The science teaching attitude instrument consists of 30 statements related to the nature of children, the nature of science for the elementary school and the role of the elementary science teacher. The test has been judged to be valid in terms of the objectives for university science methods courses and has a reported test-retest reliability of 0.74 (Strewitz, 1976).

The Science Classroom Behavior Q-sort is an eighty item instrument used to measure teachers' beliefs about desirable classroom behaviors. It has been judged to have high content validity. Additionally it has reported test-retest reliability of 0.810. It contains eight major categories of behavioral items. These are warmth, indirectness, social system, knowledge, flexibility, discipline, management, and communication.

Treatments: The treatment groups consisted of 3 alternative science methods instruction classes. One course was taught in an open classroom mode where field experiences in selected team taught open classroom settings accounted for over ½ of the instructional time. A second course was taught in a self contained classroom mode where observations and teaching activities were planned in one teacher classrooms and accounted for about ¼ of the instructional time. The third course was the traditional on campus science methods course which utilized very few instructional field experiences.

The time spent in the instructional treatment groups was 150 minutes a week for fifteen weeks. The instructional content for the courses was also basically the same. All students completed science education modules related to (1) Piaget's, Bruner's, and Gagne's theories and elementary science instruction, (2) science teaching objectives, (3) science teaching content objectives, (4) science teaching attitude objectives, (5) observation, classification, and measurement activities, (6) teaching by discovery, guided discovery and experimental inquiry

activity methods, (7) analysis and use of elementary science textbooks, (8) teaching ESS, SCIS, and S:APA units, (9) evaluation in elementary science, and (10) planning for science instruction. Other activities varied according to student selected individual projects. Basically the treatments differed in the amount of time spent in classroom settings, the types of classroom settings in which the students were placed, and types of individually selected science education activities students chose to complete.

Analysis of the Data: Data for each measure were analyzed separately. The PMT Questionnaire results were analyzed with analysis of covariance procedures. The pre-test score was the covariate. This procedure was chosen because initial analysis of pre-test scores showed the groups were not equivalent. The science teaching attitude results were analyzed utilizing analysis of variance procedures. This procedure was chosen because initial analysis of the pre-test scores showed equivalence of groups on this measure. The Science Classroom Behavior Q-sort results were analyzed utilizing factor analysis procedures.

Results: The overall analysis revealed that the students in the different courses did exhibit significantly different attitudes and beliefs about teaching. Table 1 reports the means of each group in the subscales of the PMT Questionnaire and the science attitude scale.

Table 1 about here

On the PMT questionnaire there was a significant main effects result on the punishment subscales but not on the classroom management and control subscales or on the trust subscales. Talbes 2, 3, and 4 report the analysis data pertinent to the results. The open block of students had significantly less constraining ideas about punishment of children in the school environment.

Table 2, 3, and 4 about here

On the science teaching attitude instrument the groups were not significantly different in their overall scores. Only one item showed significant main effects among groups. This was item 8 which states that "Allowing children to do what they want when working with science equipment in the classroom will result in many discipline problems." However, many other items nearly reached the 0.05 level of significance. Overall the open block students ranked items 3, 16, 19, 21, 22, and 25 higher than did the other groups. The self-contained block students ranked items 5, 6, 7, 8, 9, 13, 14, 18, 20, 23, 26, 28, 29, and 30 higher than did the other groups. The on-campus block students ranked items 1, 2, 4, 10, 11, 12, 15, 17, 24, and 27 higher than did the other two groups. Table 5 reports the mean scores by groups for each of the items.

Insert table 5 about here

The factor analysis of the pre-service elementary science students beliefs about teaching behaviors revealed four groupings of students. One group basically identified with humanistic psychological ideas, a second group identified with behavioristic psychological theories, a third group appeared to have beliefs related to Gestalt or field psychological theories, and the fourth group could not be easily characterized. These groupings of students were not significantly associated with either of the particular groups studied.

DISCUSSION

This study revealed that attitudes about teaching form a complex schema for most pre-service elementary teachers. This overall schema often determines whether or not a teacher even teaches science. Overall the existence of various combinations of field experiences did not seem to affect students attitudes to a great extent. In fact the on-campus students exhibited the most willingness to pursue a variety of science experiences for children and to rely on children to help structure some of their learning. This result was not expected. The introduction into the real teaching world and the socialization in the schools seems to often be influential on making all students view teaching in a homogeneous way. Students in the open classrooms section did rank items about student higher, though not significantly higher, than did students in the other sections. They also showed a preference for the ESS materials. Guided discovery and rational inquiry modes of instruction appeared to be the most useful for on campus students, while students in the self contained section chose to use total unit instruction based on textbook selected conceptual schemes or SCIS materials. These findings are important since they indicate that varying teaching approaches are most similar to the beliefs of the different groups of students and thus will probably be the ones that are most effective for each group.

If universities are to meet individual pre-service elementary students needs, they must continue to devise and analyze outcomes from a variety of alternative science education programs.

TABLE 1

MEANS FOR GROUPS IN CRITERION MEASURE

Criterion	Open Block	Self Contained Block	Campus Block
PMT Subscale Trust	67.30	66.15	65.65
PMT Subscale Management/Control	68.83	67.01	64.97
PMT Subscale Punishment	62.74	59.92	59.81
Science Teaching Attitude Scale	2.84	3.04	2.91

TABLE 2

ONE WAY ANALYSIS OF COVARIANCE: ATTITUDE TOWARD MANAGEMENT/CONTROL

Source of Variations	Sum of squares	Mean Square	F	. Probability
Covariate	1039.253	1039.253	40.792	.001
Main Effects Group	83.590	20.897	0.820	.999
Residual	1706.938	25.477		
Total	2829.791	39.303		

TABLE 3

ONE WAY ANALYSIS OF COVARIANCE: ATTITUDES TOWARD PUNISHMENT

Source of Variation	Sum of Square	Mean Square	F	Probability
Covariate	2023.11	2023.11	106.715	.001
Main Effects Group	211.686	59.922	2.792	.033
Residual	1270.189	18.958		
Total	3504.986	48.680		

TABLE 4

ONE WAY ANALYSIS OF COVARIANCE: ATTITUDES TOWARD TRUST

Source of Variation	Sum of Square	Mean Square	F	Probability
Covariates	936.025	936.025	29.388	.001
Main Effects Group	68.295	17.074	.536	.999
Residual	2134.009	31.851		
Total	3138.329	43.588		

TABLE 5

MEANS FOR GROUPS ON SCIENCE TEACHING ATTITUDE ITEMS

Item Number	Open Block	Self Contained Block	Campus Block
1	3.9	4.2	4.3
2	3.9	4.0	4.2
3	3.2	2.6	2.8
4	1.7	1.8	1.9
5	3.0	4.2	3.1
6	1.2	1.6	1.3
7	2.8	3.2	2.5
8	1.8	2.8	1.9
9	1.9	2.4	2.3
10	2.0	1.6	2.1
11	3.4	3.6	3.6
12	3.6	3.2	3.8
13	2.2	3.0	2.6
14	2.9	3.2	2.8
15	3.2	3.4	4.1
16	3.9	3.2	3.8
17	2.4	2.6	3.1
18	2.6	3.4	3.0
19	3.9	3.6	4.0
20	1.7	2.4	1.8
21	4.0	3.6	3.8
22	4.1	3.2	3.8
23	1.8	2.6	2.3
24	2.8	3.0	3.6
25	3.2	2.4	3.0
26	3.8	4.0	3.8
27	1.8	2.0	2.1
28	3.0	3.6	2.5
29	2.0	3.0	2.2
30	3.7	4.0	4.0

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